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TYPHOID FEVER

Prevalence, Cause, Restriction and Prevention

Published at Helena, by the State Board of Health.

"Public health is purchasable. Within natural limitations a community can determine its own death rate."

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TYPHOID FEVER*

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Typhoid fever is a germ disease, that is, it is due to a small living organism. The typhoid germ does not develop by "spontaneous generation" out of lifeless matter, nor does it come into existence suddenly, but only as the descendant of another germ of the same kind. If all typhoid germs now living could be destroyed, the disease itself would cease to plague us. Although immediate and complete extermination of all typhoid germs is an impossible task, if we can in any way materially lessen their number, we shall also diminish the frequency with which infection occurs. One rattlesnake in a town is less dangerous than ten thousand rattlesnakes. In this sense typhoid fever is a preventable disease. If we can keep away from the typhoid bacillus or can keep it away from us, we shall not have typhoid fever. We cannot see the bacillus without a microscope, but fortunately we know where it lives and how we are likely to come into contact with it, so that we are able to do much to protect ourselves.

Typhoid fever is a disease restricted to man. None of the domestic animals suffer from it. In consequence, methods of prevention are in some respects simpler than in the case of a disease which, like tuberculosis, afflicts animals as well as man.

EARLY RECOGNITION OF TYPHOID FEVER IMPORTANT

For purposes of prevention as well as cure it is important to recognize the existence of typhoid fever in an individual or in a community as early as pos-

* This pamphlet is one of a series on public health, prepared by the Council on Health and Public Instruction of the American Medical Association. Other pamphlets can be secured from the Secretary of the State Board of Health or from the Council on Health and Public Instruction, American Medical Association, 535 North Dearborn Street, Chicago.

sible. The symptoms of typhoid fever, like those of other infectious diseases, are not the same in all persons. There are all grades of severity, from the extremely severe and fatal cases to those in which the patient thinks he is suffering merely from a slight "indisposition" or "bilious attack," is able to keep about his work and perhaps never calls in a physician. Even in severe cases some of the usual symptoms of typhoid fever may be lacking, so that early diagnosis is uncertain or impossible. It is less than a hundred years since typhoid fever began to be distinguished by

Fig. 1.—This reproduction of a photograph shows a privy overhanging a small brook, one of the feeders of the Merrimac River, Massachusetts, only 2½ miles above the intake of the Lowell water-works. The privy was used in October, 1890, by a patient in the beginning stages of typhoid fever. The use of this outhouse by the patient was followed by an outbreak of typhoid fever in Lowell, numbering several hundred cases. (From Sedgwick's Investigations of Recent Epidemics of Typhoid Fever in Massachusetts, 1892.)

physicians from other "slow" or "continued" fevers, and there are still some cases in which physicians have to base their diagnosis on "symptoms" alone, and have not the aid which comes from the laboratory tests. Typhoid may be mistaken for malaria or for other infections. From the point of view of prevention it is highly important that a diagnosis of typhoid fever be made as early and as accurately as possible in order that suitable means shall be taken to prevent infection of others by the sick person. The physician with modern scientific training can now by means of blood

tests determine positively whether the patient is suffering from typhoid infection or not. These tests should be made in all cases.

The importance of recognizing as many cases of typhoid fever as possible and recognizing them early is very great. The typhoid germ lives almost exclusively in the living human body and cannot as a rule keep alive very long apart from its human host. The disease is kept alive, therefore, mainly by the transfer of the living germ from the person in whom it has grown, usually a typhoid patient, convalescent, or car-

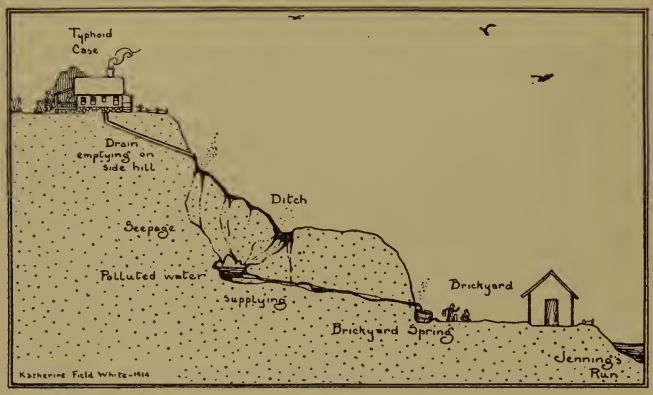


Fig. 2.—The spring at the brickyard furnished an abundant supply of clear water "of pleasant taste and appearance and agreeable coolness." Following the development of a typhoid case in the cottage on the hill, 108 of the 200 workmen in the brickyard became ill with typhoid fever. (Adapted from a study of an epidemic in 1906 at Mount Savage, Md., by Stokes and Price, Maryland Med. Jour., December, 1906.)

rier, to a healthy person who becomes a breeding-ground for it, and in his turn passes it on to one or to hundreds of others. It is one of the urgent tasks of public hygiene to break this chain of typhoid germs at as many points as possible.

REPORT TYPHOID CASES

To this end it is necessary to establish in each community or group of communities some central health office to which the physicians shall report every case or suspected case of typhoid fever coming under their observation. Only in this way can the beginnings of an epidemic be detected and measures taken to prevent further spread. One or two typhoid cases in

the practice of a busy physician naturally do not appear to him especially significant, but if several physicians report cases occurring about the same time so that the total number in the town is suddenly increased to an unusual degree, the health authorities are at once made acquainted with the situation and can try to discover the source of the outbreak. Only in this way, too, is it possible to place each case

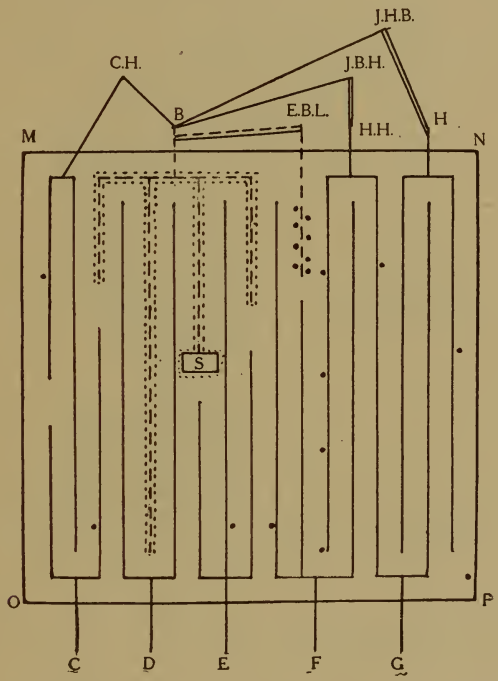


Fig. 3.—Stamford typhoid fever epidemic, April 15 to May 28, 1895 (Herbert Smith: Connecticut State Board of Health Report, 1895, p. 161). Stamford had a population of 15,000. The large square *M N O P* represents the town of Stamford. *B* is the dairy distributing the implicated milk, and the dash-lines running from *B* into the city represent the milk-route of the dairy. Each of the dots represents one case of typhoid fever, and is placed on the route of the dairy from which it was supplied with milk. There are 368 such cases on *B's* route, including the 12 around the *S*, which is meant to represent the café supplied by *B*. *B* supplied about one-eleventh of the milk used in the town. *HH* and *H* are distributing dairies similar to *B*. *CH* and *EBL* are producing farms selling milk to *B* and also peddling some themselves. The dash-line extending from *EBL* represents his personal route of 5 houses in which 8 cases of typhoid occurred. *JHB* and *JBH* are producing farms selling milk to *B* and also to distributing dairies *H* and *HH*. The double lines show the dairy to which the producer sold most of his milk. Dash lines show the apparent course of the infective agent. *C, D, E, F,* and *G* are other dairies having routes in Stamford.

of typhoid fever under the centralized supervision that it must have in order to lessen the chance of further scattering of disease germs throughout the town. Family and friends must be warned of the danger of close association with the patient. In some instances in which expert nursing cannot be provided, special precautions must be taken to insure the disinfection of the excreta. For all these reasons it is

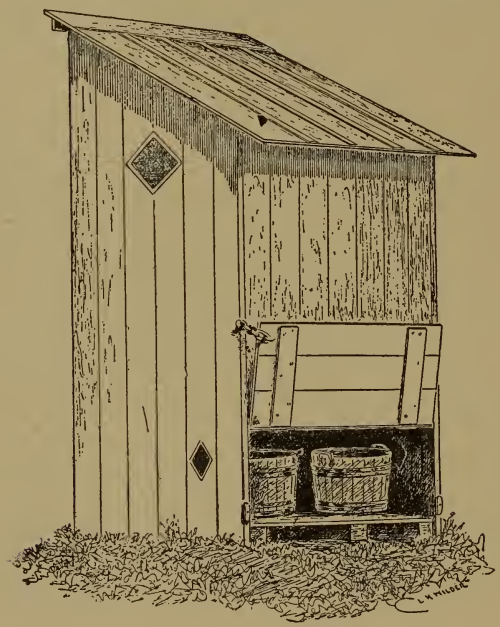


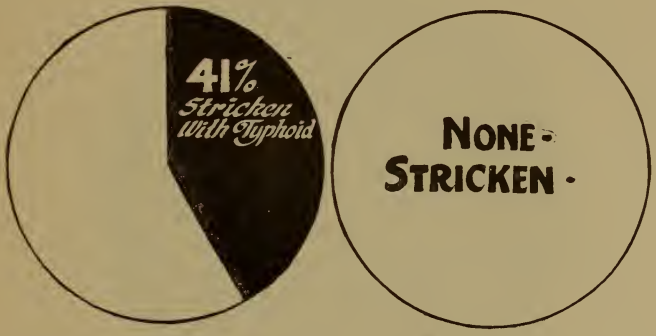
Fig. 4.—This sanitary privy with raised back is fly-tight and is so arranged that the buckets or tubs within do not touch the ground. (From the Virginia Health Bulletin, June, 1911.)

easy to see why prompt notification of every suspected case of typhoid fever is the first important step in preventing spread of the infection.

WHERE THE TYPHOID BACILLUS IS FOUND

While the typhoid bacillus makes its true home in the human body and does not thrive in water, soil or the bodies of the lower animals, it is nevertheless able to live for a few hours or days after it leaves the body of its host. This fact explains why typhoid fever is sometimes caused by germs that have

traveled many miles away from the person in whose body they originally grew. Typhoid bacilli are discharged from the body in (1) the feces, (2) the urine and rarely (3) the sputum. They may be present in these excretions in enormous numbers. A single drop of urine may contain as many as one million living typhoid germs. Clothing, bedding, table utensils, in fact any object used by, or coming into contact with, a typhoid patient may easily become contaminated with typhoid bacilli even when ordinary care is used. It has long been known that members of the family and especially those nursing typhoid patients are very liable to contract the disease. Any



Jacksonville, Fla., 1898; Seventh Army Corps, U. S. Army; 10,759 men, none given typhoid vaccine.

U. S. Army, San Antonio, Tex., 12,801 men, all given typhoid vaccine.

Fig. 5.—Results of typhoid inoculation. (From Washington State Board of Health Bulletin, May, 1912.)

one can see why this is so. Merely swallowing the typhoid germ is sufficient to produce typhoid fever.

It is difficult to avoid swallowing typhoid bacilli whenever persons must live for days or weeks in close association with a patient who may be discharging daily hundreds of millions of germs. Ordinary washing or rinsing of the hands does not render them safe. The attendant of a typhoid patient, after going to the sick-room or handling anything from it, should wash the hands thoroughly with soap and water and, if possible, use also a disinfectant solution such as 1:2,000 mercuric chlorid. compound solution of cresol, or 70 per cent. alcohol. Towels, door-knobs, articles of furniture or clothing may be the means of conveying typhoid bacilli to the hands. The hands may

in turn be used for breaking or handling bread, cake or other articles of food and so introduce typhoid bacilli into the mouth. Hand infection is one of the most common causes of typhoid fever, and close association with typhoid patients must always be looked on as dangerous. The danger can be reduced by removal of typhoid patients to the hospital. Unskilled home nursing, however painstaking and affectionate, will always imperil the household. This is particularly the case if the person caring for the patient also has to do with the preparation of food for other members of the family. Even in hospitals, experienced

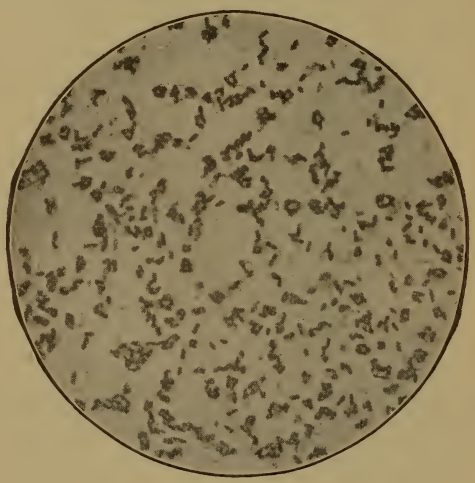


Fig. 6.—Bacillus Typhosus

nurses and attendants are likely to contract the disease unless great care is taken. All nurses of typhoid patients and all persons living in houses in which typhoid patients are being cared for should be protected by typhoid vaccination

WATER-BORNE INFECTION

The direct handing over of typhoid germs from one person to another is only one way in which the disease is transmitted. Typhoid bacilli sometimes find their way into food or drink used by large numbers of persons and give rise to extensive outbreaks. Public water-supplies and milk-supplies are two of the most common sources of typhoid infection. In many

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localities the connection between water-supply and sewerage systems is far too close. The enormous amount of water required for large cities in this country can seldom be obtained absolutely free from sewage contamination. When typhoid germs leave the body in the excreta they are likely to pass into the sewerage system.[1] It does not take a large quantity of sewage to produce infection. The discharge of a single patient, even when diluted with several million gallons of water, have been known to give rise to over one thousand cases of typhoid fever. This is not so

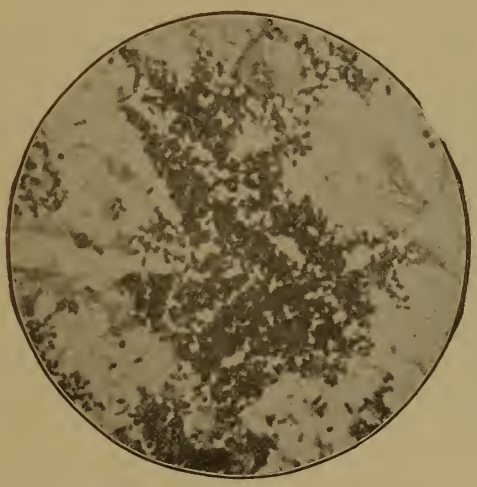

Fig. 7.—Bacillus Typhosus Agglutinated

remarkable as it seems if we remember that the number of typhoid bacilli discharged in one day may easily

1. It might be supposed that if all the excretions from typhoid patients were sterilized the disease would cease to exist, and it is undoubtedly true that the prevalence of the disease would be greatly diminished if thorough disinfection of typhoid excreta were more generally practiced. Unfortunately, the matter is not quite so simple. Besides the mild cases of the disease already mentioned which never come under the care of a physician, and the irregular cases which are not definitely recognized as typhoid, there are some convalescents who continue to discharge living and virulent typhoid bacilli from their intestines long after complete recovery has taken place. In addition there are certain patients, probably rather numerous, who have begun to discharge typhoid bacilli in the feces before typical symptoms have appeared and before they have submitted themselves to the care of a physician. Even with the great improvement that would come if the disinfection of the excreta of all known typhoid patients were strictly carried out, those persons in the groups just described would be sufficiently numerous to propagate the disease. All sewage must be regarded as infectious.

reach 5,000,000,000, or more than ten germs in every gallon of water in a large supply like that of Chicago.

Surface water-supplies such as rivers and lakes are especially liable to sewage contamination, and with the growth in density of population in this country such pollution seems likely to increase rather than diminish. Under present conditions all sewage must be regarded as possibly containing typhoid germs. In many localities it is not considered practicable to render sewage entirely free from intestinal bacteria before its discharge into large lakes or water-courses. Water-supply officials are hence right in advocating purification of all water-supplies not obtained from perfectly pure sources. Purification and consequent freedom from disease germs may be secured either by filtration on a large scale or on emergency by treatment with calcium hypochlorite (bleaching-powder). Even carefully protected water-supplies from thinly settled districts are liable to accidents. In Germany this is recognized to the extent of requiring the purification of all surface waters used for city supplies.

Fig. 8.—North side of Rockford reservoir, showing privy within 5 feet of wall. (Jordan and Irons, the Rockford (Ill.) Typhoid Epidemic.)

In country districts, also, water may be a vehicle of typhoid infection. Wells so placed as to receive drainage from privies are a source of danger. In limestone regions the beautiful but treacherous "springs" need to be examined with special care, since the so-called springs are often only small surface streams and brooks which emerge at the surface after a longer or shorter flow through underground

channels. If seen in the beginning as a brook the water would be recognized by every one as coming from dangerous localities, while as a "spring" it might be drunk without suspicion of its filthy origin.

Water-drinking is not the only way in which typhoid fever may be contracted from polluted water. While bathing in polluted water, either salt or fresh, one may accidentally swallow small quantities of water, and this has been known to give rise to typhoid fever.

Measures to prevent the spread of typhoid fever by means of water-supply may be summed up as follows: Prevent in every way possible the entrance

Fig. 9.—West end of Rockford reservoir. (Jordan and Irons, the Rockford (Ill.) Typhoid Epidemic.)

of typhoid germs into sewers or into privy vaults by thorough disinfection of all discharges from the body of a recognized typhoid patient.[2] In spite of all precautions some typhoid bacilli will get into the sewage and hence such sewage must be always regarded as probably infective. Sewage should be kept out of all water sources used as drinking water-supplies. All of the usual methods of treating sewage, such as sedimentation, precipitation, filtration, and the like, diminish the danger of water-borne typhoid fever even if they

2. Typhoid stools may be disinfected by adding enough hot water to cover the stools in the receptacle together with about a cupful of commercial unslaked lime (quicklime). The lime should be in lumps, broken up in small pieces and distributed over the stool. The mixture should stand for two hours. Chlorinated lime (¼ pound in 1 gallon of water) solution can also be used.

do not altogether remove it. A more effective barrier against typhoid bacilli in water is the purification of the water-supply itself by storage, filtration or treatment with bleaching powder. Finally, if municipal methods are inadequate and there is reason to fear that typhoid bacilli sometimes get into the water-mains, security against water-borne infection may be obtained in the household by boiling the water for five miuutes.

In the country the purity of the drinking-water rests largely in the control of each family. Shallow wells should be protected against surface wash and should be so located that the contents of privy vaults and out-houses can by no possibility leak through the soil into

Fig. 10.—Ordinary cow barn, transformed into a sanitary barn. The work was done by the owner and his farm help at small expense.

the well-water. Deep driven wells protected from surface contamination constitute a particularly safe source of supply.

MILK-BORNE INFECTION

Milk, like water, can be the means of introducing typhoid bacilli into the body. Several hundred well-marked epidemics of typhoid fever are on record which have been traced to milk containing typhoid germs. The bacilli may get into the milk in various ways. When a person suffering from a mild or unrecognized case of the disease is engaged in the collection or distribution of milk, or when flies have access to the contents of a privy vault in which typhoid bacilli happen to be present and at the same

time have access to the milk-house, or when milk-cans or bottles are rinsed in impure water just before filling, or are not sterilized after removal from a house in which typhoid fever prevails, the possibilities

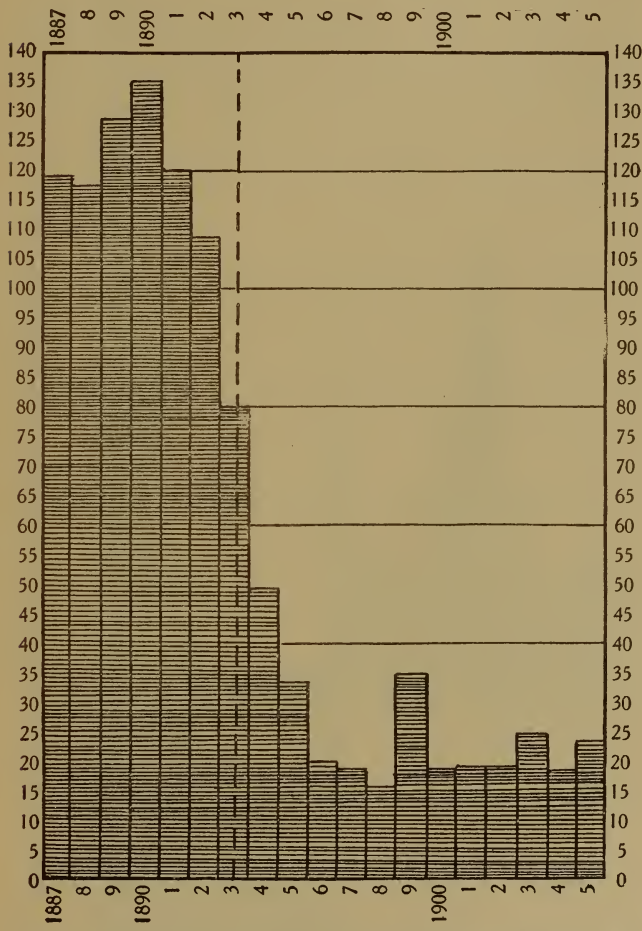

Fig. 11.—Diagram showing the relation between the water supply and the typhoid death rate in Lawrence, Mass. (Whipple.) Filtration commenced at the dotted line.

of infection are clear enough. Unlike water, milk may serve as a medium for the multiplication of typhoid bacilli so that a small amount of infected milk mixed with other milk at a creamery may lead to the

distribution of many more bacilli than were originally present. Such multiplication probably goes on for only a limited period while the milk is still quite fresh. The danger of infection from buttermilk or from butter made from sour cream is much less than from fresh milk. Protection against milk-borne typhoid may be easily secured by boiling or pasteurizing all milk not known to be safe. Typhoid bacilli are killed by exposure for ten minutes to a tempera-

Fig. 12.—Diagram showing the relation between the water supply and the typhoid death-rate of Hamburg, Germany. (Whipple.) Filtration began at the dotted line.

ture of 60 C. (140 F.), so that efficient pasteurization constitutes an excellent safeguard. It is plain also that milk should not be distributed from farms on which typhoid fever exists, and that on all dairy farms human excreta should be regarded as highly dangerous and should be disposed of with particular care.[3]

3. A simple and inexpensive sanitary privy adapted for use on the American farm is described in a bulletin of the United States Department of Agriculture. This bulletin (Farmers' Bulletin 463), may be obtained free of cost from the State Board of Health or from the Department of Agriculture, Washington, D. C. It gives full working directions for the construction of the sanitary privy.

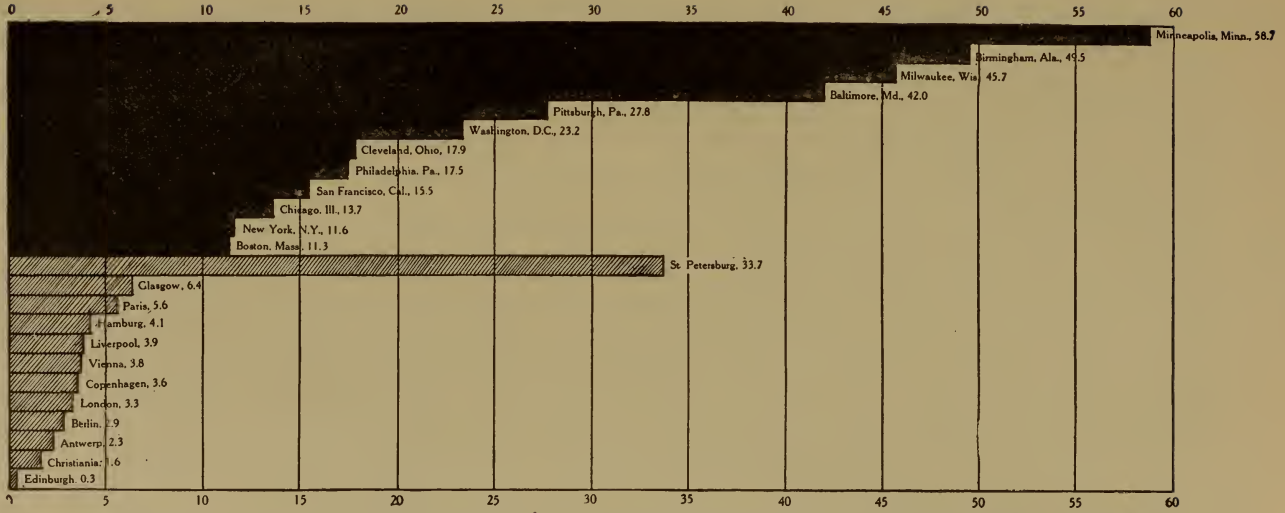

Fig. 13.—Comparison of death-rates from typhoid fever of European cities and cities of the United States. (McLaughlin.) 1910.

TYPHOID FROM OTHER RAW FOODS

Besides milk some other articles of food seem particularly exposed to possibilities of typhoid contamination. Oysters and other shell-fish that have grown in sewage-contaminated waters or that have been placed to "fatten" by "floating" or "drinking" near the mouths of sewage-polluted creeks have been shown to harbor the typhoid bacillus, and when eaten raw to produce more or less extensive typhoid outbreaks. Thorough cooking of shell-fish does away altogether with the possibility of infection through this source. In the United States, inspection and control of oyster beds by state and national health authorities have greatly reduced the possibilities of danger from the use of raw oysters. Certain vegetables or berries commonly eaten uncooked may become contaminated with typhoid bacilli if night-soil is used as a fertilizer on truck gardens, or if raw

1898, Spanish War, Camp at Jacksonville, Fla.

No. of Troops	Cases of Typhoid		Deaths, Typhoid	All Deaths
	Certain	Certain and Probably		
10,759	1,729	2,693	248	281
1911, Camp at San Antonio, Texas				
12,801	1	——	0	11

Fig. 14.—Table showing efficiency of typhoid vaccination. Majo. F. F. Russell, in Bulletin 3, Vol xiii, issued by the Vermont State Board of Health, March 1, 1913.

sewage is used for irrigation. The use of human excreta as fertilizer for certain crops, such as celery, lettuce, or strawberries, is most undesirable. In a few instances definite outbreaks of typhoid fever have been shown to be due to the use of raw vegetables or fruits. The difficulties in the way of tracing infection to the use of such articles are plainly very great, and many investigators are of the opinion that a larger amount of typhoid fever is due to the use of contaminated raw foods than can at present be actually proved.

FLY-BORNE INFECTION

Under conditions in which human excreta are exposed to the visits of house-flies, the possibility of spreading infection through the agency of these

insects is well recognized. Back and forth from privy vault to eating-table wander these bearers of infection. At the time of the Spanish-American War when lime was used in the camp latrines, flies with their legs whitened with lime were afterward seen walking over the food on the mess-tables. Conditions favoring fly-borne typhoid fever are especially favorable on the farm as well as in military encampments, lumber or construction camps, and the like. Reduction in the number of the flies, which can be effected especially by elimination of their breeding-places, of which horse-manure is one of the most common, together with proper disposal of excretal refuse, will greatly diminish if not altogether remove danger from this source. A room or hospital ward containing typhoid patients should be carefully screened in fly-time. It must be remembered that the fly can act only as the mechanical carrier of typhoid bacilli. However disgusting and annoying the fly's habits may be, if it does not have access to material in which typhoid bacilli are present, it cannot convey typhoid fever.

There is no evidence that typhoid fever is ordinarily air-borne. Under unusual conditions it is possible that dried excreta might be blown about as "dust" and that typhoid bacilli might then come to settle on food or possibly even be inhaled and swallowed, but this mode of infection is probably very rare. The immediate neighborhood of a typhoid patient is dangerous not because there are any typhoid bacilli floating in the air, but because of the likelihood that objects in the room—pillows, arms of chairs, door-knobs—have been accidentally contaminated in the care of the patient.

TYPHOID CARRIERS

The fact has already been mentioned that well-defined and active cases of typhoid fever are not the only ones that may be discharging typhoid bacilli. The importance of healthy typhoid carriers needs to be still further emphasized here. Recent investigations have shown that from 4 to 6 per cent. of all persons recovering from typhoid fever continue to discharge typhoid bacilli in the feces or urine or both

for months and even years after complete recovery. Occasionally, also, a person who has never had a recognized case of typhoid is found to be a carrier. Plainly, such persons are likely to be starting-points of fresh infections, especially if, as in the famous case of the New York cook, "Typhoid Mary," their occupation is concerned with the handling or preparation of food. "Typhoid Mary" was the cause of twenty-six cases of typhoid among the members of seven different families for whom she worked.

An undetected carrier on a dairy farm may be the cause of an explosive outbreak, or of scattered cases along the milk-route during a considerable period. No satisfactory means have yet been found for permanently ridding these typhoid carriers of the germs that they harbor. Carriers, when found, must be warned of the possible havoc they may scatter among relatives and friends, and so far as possible should be prevented from engaging in occupations which involve a maximum hazard to the community. Since the number and identity of such carriers in a community are at present not readily ascertainable, all sewage and the contents of all privy vaults must be looked on as possibly infectious. The chance use by a visiting typhoid carrier of an improperly constructed outhouse in a small country town or on a dairy farm may be the starting-point of a serious outbreak whose origin will always be "mysterious." While the problem of dealing with typhoid carriers is very difficult, it cannot be forgotten that the outlook in general is a very hopeful one. Any diminution in the number of water-borne or milk-borne epidemics will avoid the production of new carriers. The improvement is bound to be progressive. Every reduction in the amount of typhoid fever automatically lessens the number of carriers.

It can be seen from the foregoing that improper disposal of excretal refuse is at the bottom of most typhoid fever infection. Particularly is this so in country districts, where fly-borne infection is most likely to take place, and where the bulk of milk infection, from which city dwellers later have to suffer, also occurs.

TYPHOID VACCINATION

It has been found that injection of killed and harmless typhoid bacilli will protect against typhoid infection even in persons particularly exposed by their occupation or other social conditions. In the United States Army, in which typhoid vaccination has been compulsory since September, 1911, the disease has practically disappeared. In 1909 there were 173 cases and 16 deaths in a force of about 69,000 men; in 1912, only 27 cases and 4 deaths in about 83,000. From August, 1912, to August, 1913, there were only 2 cases. Many of these troops were engaged in maneuvers in Texas (1911-1912) and were associated more or less intimately with the civil population, among whom typhoid cases were occurring in considerable numbers. Owing to the conditions under which soldiers must live in the field or on the march, the likelihood of typhoid fever is great. In 1898 at the time of the Spanish-American War, 4,422 cases of typhoid and 248 deaths occurred in a division of 10,759 men; among 12,801 vaccinated men under very similar conditions at San Antonio, Tex., in 1911, only one case developed.

Similar results have been obtained in hospitals in which typhoid patients are cared for and in which in the past many cases have developed among the nurses. In one large hospital inoculation of the nurses was followed by a year of entire freedom from the disease among nurses and attendants for the first time in the history of the institution. The lesson is plain. All persons whose occupation tends to expose them to typhoid infection should be vaccinated. Nurses, physicians, soldiers and all those whose manner of life leads to frequent travel and to eating in a variety of restaurants, hotels, or to drinking of water of unknown source come under this head.

What is commonly known as "vacation typhoid" is chiefly the typhoid picked up by contact with infection during travel. In a word, the larger the number of places to which one resorts for food and drink the greater is the chance of crossing the trail of a typhoid carrier. Vaccination gives a high degree of protection for three years, perhaps for a longer period. For those who are not directly exposed to known typhoid

infection, but who realize the possibilities of infection through intercourse of urban life, typhoid vaccination, which has been clearly shown to be both safe and efficient, offers an attractive and cheap form of insurance against typhoid fever.

RULES FOR PREVENTING TYPHOID FEVER

For the Individual:

1. Keep away from all known or suspected cases of typhoid.
2. Wash hands thoroughly before meals. Do not use "roller towels."
3. Use drinking-water only from sources known to be pure, or if this is not possible, use water that has been purified by municipal filtration or by hypochlorite treatment or by boiling in the household.
4. Avoid bathing in polluted water.
5. Use pasteurized or boiled, instead of raw, milk.
6. Select and clean vegetables and berries, that are to be eaten raw, with the greatest care.
7. Avoid eating "fat" raw oysters and, in general, oysters and other shell-fish whose origin is not known.
8. Be vaccinated against typhoid in all cases in which any special exposure is known or feared.

For the Community:

1. Insist on the hearty cooperation of all persons with an efficient health officer.
2. Require notification and a reasonable degree of isolation of every known or suspected typhoid case.
3. Exercise strict control over the disinfection of known typhoid excreta.
4. Insist on pure or purified water-supplies.
5. Require pasteurization of milk-supplies.
6. Regard all human excreta as possibly dangerous, and control their disposition in such a way as to prevent contamination of food or drink.